Landslide Hazard Assessment and Mapping in the Guil Catchment (Queyras, Southern French Alps) From Landslide Inventory to Suscepbility Modelling

Louise Roulleau, François Bétard, Benoit Carlier, Candide Lissak, Monique Fort, Matthieu Fressard

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From Landslide Inventory to Susceptibility Modelling

Louise Roulleau[1,3], François Bétard[1,3,*], Benoît Carlier[1,3], Candide Lissak[2,3], Monique Fort[1,3], Mathieu Fressard[2]

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Introduction

Context. Landslides are common natural hazards in the Southern French Alps, where they may affect human lives and cause severe damages to infrastructures. As a part of the SAMCO research project dedicated to risk evaluation in mountain areas, this study focuses on the Guil river catchment (317 km²), Queyras, to assess landslide hazard poorly studied until now. In that area, landslides are mainly occasional, low amplitude phenomena, with limited direct impacts when compared to other hazards such as floods or snow avalanches. However, when interacting with floods during extreme rainfall events, landslides may have indirect consequences of greater importance because of strong hillslope-channel connectivity along the Guil River and its tributaries (i.e. positive feedbacks). This specific morphodynamic functioning reinforces the need to have a better understanding of landslide hazards and their spatial distribution at the catchment scale to prevent local population from disasters with multi-hazard origin.

Objective. The aim of this study is to produce a landslide susceptibility mapping at 1:50 000 scale as a first step towards global estimation of landslide hazard and risk.

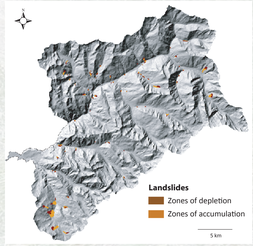
Active landslide scar above the village of Aiguilles, Queyras. March 2014.

1. Study area

- **Geographical setting**
  - An Alpine catchment of 317 km², between 868 and 3357 m a.s.l.
  - Scattered urbanization with several villages established in the main valleys

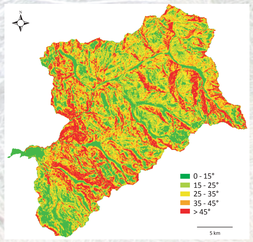
2. Landslide inventory

- **A detailed inventory of 69 landslides**
  - Extraction from national databases (BDMvt, RTM)
  - Photointerpretation of aerial images
  - Extensive field work

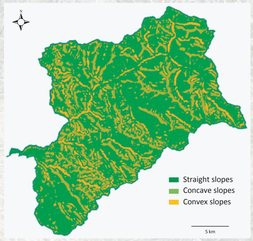


3. Predisposing factors: spatial database construction

- **Slope gradient**

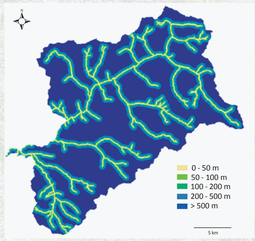


- **Slope curvature**

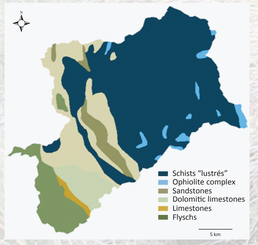


- **Aspect**

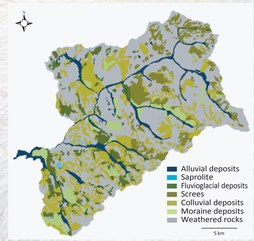
- **Distance to streams**



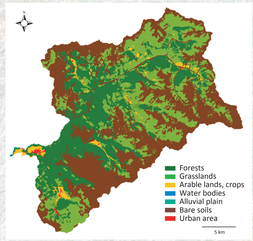
- **Lithology**



- **Surficial formations**



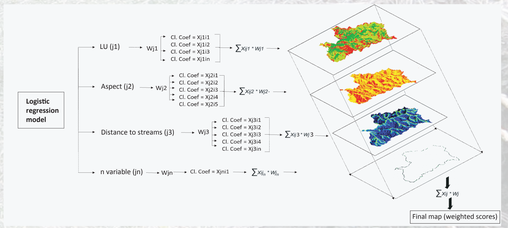
- **Land use**

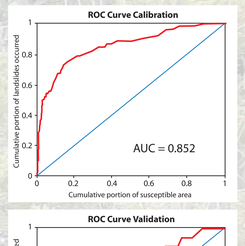


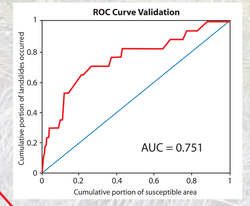
- Data constructed from **various sources** (DTM, geological maps, satellite images...) and stored in a spatial database (ArcGIS©)
- Selection as input variables to be included in the model after **statistical analysis** based on χ2 test and Cramer's V coef.

4. Susceptibility modelling: logistic regression results and interpretations

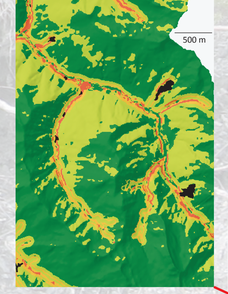
- **Logistic regression model**
  - A logistic regression model to analyze the **spatial and mathematical relationships** between the response variable (i.e. absence/presence of landslides) and the set of predictive variables (i.e. predisposing factors)
  - Model evaluation by a **calibration/validation strategy** based on ROC curve and AUC analyses (procedure details in Roulleau, 2015)

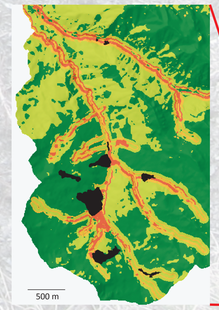


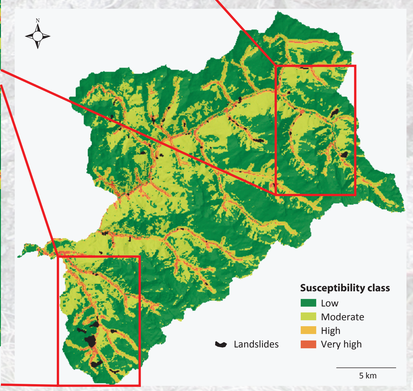




- **A strong hillslope-channel connectivity**
  - A **final susceptibility map** in 4 classes using a discretization method based on Jenks natural breaks
  - Results show the **major influence of the distance-to-streams variable** on the model => confirms the strong hillslope-channel coupling observed empirically during extreme rainfall events (Fort et al., 2015).







Undercutting triggers shallow landslides on the left bank of the Bouchet river near Valpréveyre (Abriès, Queyras). Note that the river channel is narrowed by road embankment (right bank), thus renforcing the destabilisation on the opposite bank. March 2014.

References

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Roulleau L. (2015) - *Evaluation et cartographie de la susceptibilité aux glissements de terrain. Application dans le bassin versant du Guil. (Queyras, Alpes du Sud, France).* MSc Dissertation, Master 2 Dynarisk, Univ Paris-Diderot, 88 p.

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